

UNITED STATES MARINE CORPS

LESSON PLAN

ADIABATIC PROCESS

INTRODUCTION:

1. Gain Attention. Have you ever applied hair spray or a spray deodorant and noticed as you were holding the can that the can became colder?
2. Overview. During this period of instruction we will discuss the adiabatic and pseudo-adiabatic processes that are caused by adiabatic temperatures changes within the atmosphere. We will also look at how both of these processes affect the atmosphere.
3. Introduce Learning Objectives.
  - a. Terminal Learning Objective. With the aid of, and in accordance with the references, discuss the adiabatic and pseudo-adiabatic processes and their associated terms.
  - b. Enabling Learning Objective(s). Without the aid of, but in accordance with the references, given a parcel of air, the student shall:
    - (1) Explain how a cloud forms due to the adiabatic process.
    - (2) State the difference between the adiabatic and pseudo-adiabatic processes.
4. Method/Media. This period of instruction will be taught using the lecture method with aid of QMMCBT-001 "Introduction to the Dynamics of the Atmosphere".
5. Evaluation. The student shall not be evaluated, however, there will be a short question and answer session upon completion of this period of instruction.

TRANSITION. The adiabatic process is consistently occurring. This process is a key component to understanding the fundamental behaviors of warm and cold air. We shall begin with the adiabatic process.

BODY:

1. Adiabatic Process. The process in which no transfer of energy (heat) occurs between a system (parcel of air) and its surroundings. In the adiabatic process, compression always results in warming, and expansion always results in cooling. Thus a rising parcel of air will expand and cool and a sinking parcel of air will compress and warm. This process is reversible, meaning, that in a true adiabatic state a lifted or sinking parcel returned to its original position will have its original temperature and dew point.

a. **Adiabatic Warming.** A rising parcel of air will decrease at the dry adiabatic rate until the temperature reaches the dew point. As the parcel rises the dew point will also decrease at a rate of  $2^{\circ}\text{C}/\text{km}$ , which must be factored in determining when the parcel's temperature will drop to equal the dew point (parcel reaches the LCL). Once saturated the parcel will rise at the saturated rate.

b. **Adiabatic Cooling.** Adiabatic descent is the opposite of adiabatic rise. The parcel will descend at the saturated rate until it reaches the LCL at which point it will decrease at the dry adiabatic rate.

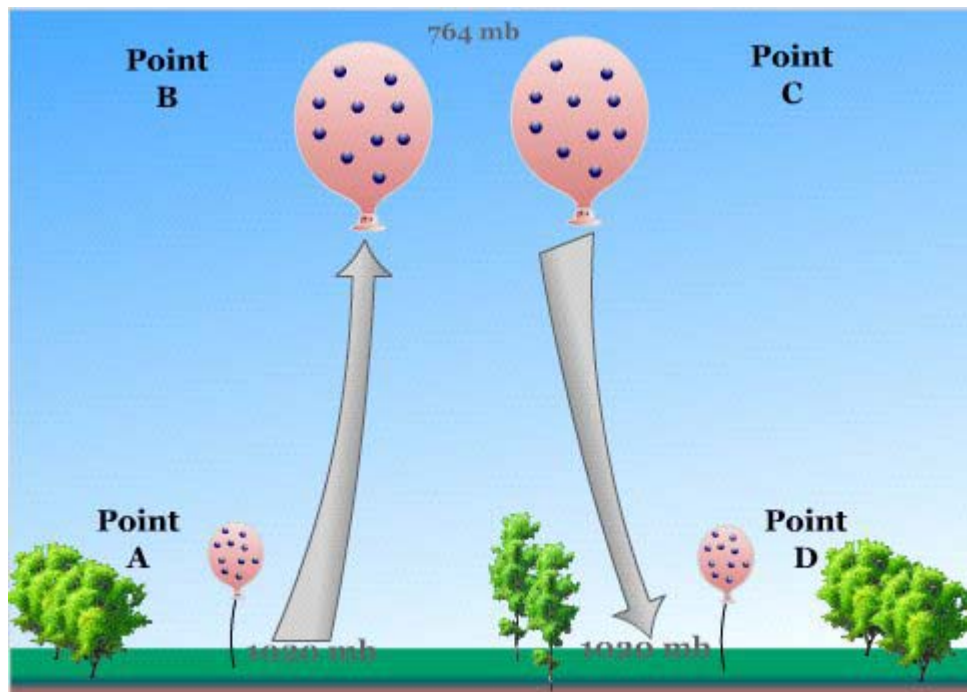


Figure 1 - Decreasing pressures aloft allow the balloon to expand and cool, while increasing pressures at the surface compress and warm the balloon.

**TRANSITION.** The adiabatic process is what would occur if there was no energy exchange between air parcels and their environment, but what would happen if energy was actually exchanged between the two?

2. **Pseudo-Adiabatic Process.** In this process it is assumed that all saturation that occurs during lift precipitates out of the parcel. This process actually occurs in nature and is most common over mountain ranges, known as "Chinook Winds". Since all saturation precipitates out of the parcel, when it begins to descend at the dry adiabatic rate. Thus a parcel will end up warmer and drier than when it began.

**INSTRUCTOR NOTE:** QMMPH1-019 extensively covers lapse rates, however a brief overview may be necessary for the following terms.

a. **Pseudo-adiabatic ascent.** A rising parcel of air will be lifted dry adiabatically until it reaches saturation (LCL). Once saturated

it will rise according to the saturated rate.

b. Pseudo-adiabatic descent. A descending parcel of air will descend at the dry adiabatic rate since the all moisture was precipitated out during ascent.

TRANSITION. It is important to remember that this process actually occurs in nature and can result in very warm, dry conditions on the lee-side of mountain ranges.

OPPORTUNITY FOR QUESTIONS:

1. Questions from the Class. At this time, are there are question pertaining to the material that has just been presented to you?
2. Questions to the Class.
  - a. QUESTION. In your own words define the adiabatic process.
  - b. ANSWER. The process in which no heat (energy) is exchanged between a system (parcel of air) and its environment.
  - c. QUESTION. In your own words define the pseudo-adiabatic process.
  - d. ANSWER. The process in which all saturation is assumed to precipitate out of a parcel resulting in a net warming and drying of that parcel.

SUMMARY: In the adiabatic process there is no exchange of energy between an air parcel and the environment. A parcel that is lifted to a certain level and then returned back to that same level will have the same temperature and dew point it started with. In the pseudo-adiabatic process it is assumed that all saturation that occurs when a parcel is lifted is precipitated out of that parcel. This process actually occurs in nature and results in a net warming and drying to a parcel.

REFERENCE.

MOAF Course Textbook (N61RCB1-ST-102) Physics I, Chapter 5, pgs. 13-15. Rev. October 2002.

Frederick K. Lutgens and Edward J. Tarbuck. The Atmosphere: An Introduction to Meteorology 9<sup>th</sup> ed. New Jersey: Pearson Education Inc., 2004.

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<http://www.adtdl.army.mil/cgi-bin/atdl.dll/fm/3-6/3-6gl.htm>